doi:10.1017/S1431927622010649
Microsc. Microanal. 28 (Suppl 1), 2022

Gamma Alumina Synthesis Following a Mechanochemical Process Obtained from Aluminum Residues

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The modern way of living and social development are frequently accompanied by increasing problems such as releasing large amounts of waste into the environment [1]. Public debris accumulates over time, resulting in severe environmental and public health problems. Moreover, the increasing demand for valuable new materials (nano-sized), the introduction of stricter environmental regulations, sympathy for sustainable production and global recycling routes has generated a new global consciousness. Thus, waste management has been converted into an important field of research based on the principles of green chemistry. Under this approach, scrap and residues can be advantageously used instead of raw and purified precursors for chemical synthesis; it is interesting because they are cheap, easily obtained and reduce carbon footprint. Recycling aluminum saves 8 Kg bauxite, 4 Kg chemical products and 14 KWh power per Kg. Thus, Al recycling has great interest from economic, energetic and environmental perspectives [2]. Gamma alumina (γ-Al_2O_3) is a material commonly employed as the main catalyst or catalytic support in some chemical reactions and control of automotive emissions due to its high surface area notable thermal and chemical stability [3].

This work aims to evaluate a method to prepare γ-Al_2O_3 from Al scrap using a mechanochemical route that exhibits similar properties to that produced from a commercial aluminum chloride hexahydrate ($AlCl_3 \cdot 6H_2O$). Four grams of can chunks were processed for ten minutes in a Spex-8000M mill; the obtained powders were mixed with the stoichiometric quantity of HCl 9M until complete dissolution (8 h), the paste was filtered and neutralized with NaOH 6M until pH=8.5. The precipitate was washed and dried at 100°C, milled in a mortar and calcinated at 550°C for 2h. As a reference, an $AlCl_3 \cdot 6H_2O$ (Fermont 24012) solution was prepared and treated under similar conditions. The morphological characteristics and compositional analyses were performed in a SU3500-SEM microscope and structural changes in processed samples were obtained by X-rays Diffraction.

Fig. 1 shows SEM-EDS analyses of the boehmite AlO(OH) powders synthesized by the chemical reaction of NaOH and $AlCl_3$ obtained from three different routes: S1) Al powder from milled cans, S2) Al can chunks and S3) reactive grade $AlCl_3 \cdot 6H_2O$ solution. As seen in the image and EDS analyses, products obtained from Al cans have a pink coloration due to Mn and Fe presence. In some catalytic applications, this condition can increase the performance of the alumina. In Fig. 2, XRD spectra confirm the boehmite existence and a small amount of γ-Al2O3, broadened and low-intensity peaks result from the material nanometer crystal size. After a hydroxylation reaction at 550ºC, γ-Al_2O_3 is formed at the expense of boehmite. The patterns are practically similar for all samples; this indicates that this phase is formed independently of the used precursor.

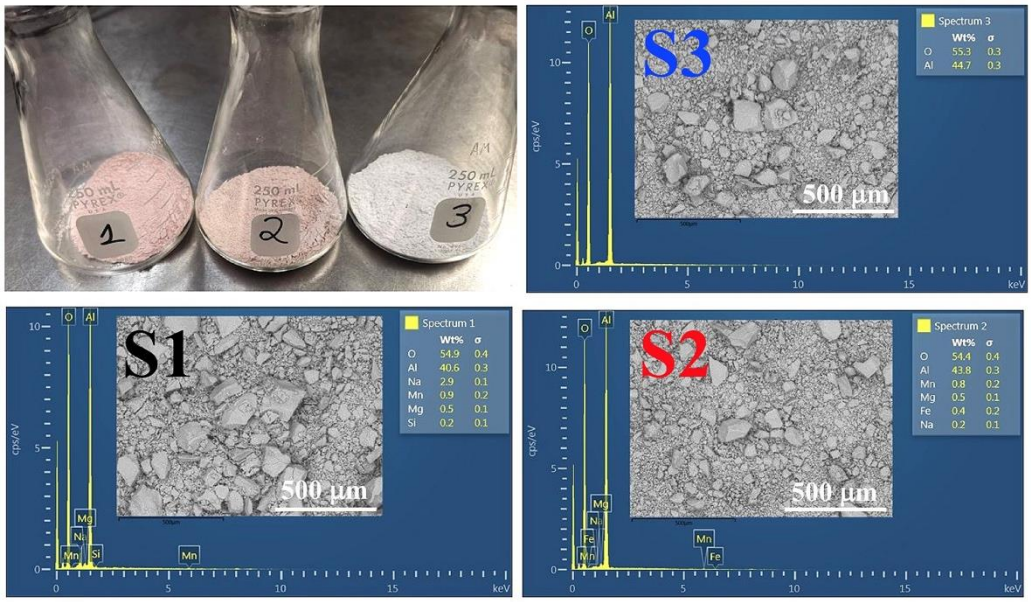

Figure 1. Dried and milled powders produced from solubilized aluminum and SEM analyses showing the general morphology and chemical composition

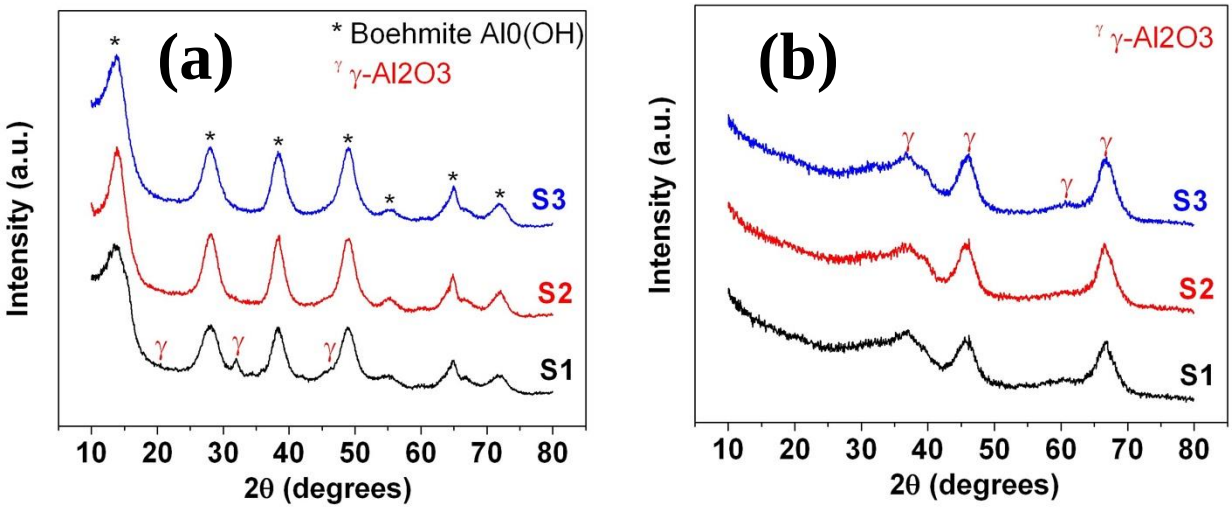

Figure 2. XRD patterns of precipitated powders before (a) and after (b) the calcination process showing the generation of γ-Al_2O_3 from the boehmite phase.

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https://doi.org/10.1017/S1431927622010649 Published online by Cambridge University Press